CLAIMS

We claim:

1. A noise reduction system comprising:

means for generating non-uniform noise energy about an inner surface and within an enclosure having at least an inlet;

at least one array of tubes each having an inlet and an outlet, the inlet and the outlet of each tube of the at least one array of tubes communicating with apertures in the enclosure and the at least one array of tubes being positioned about an outer surface of the enclosure, portions of the enclosure having an effective length L_2 between the inlet and the outlet of each of the tubes and the tubes having a length L_1, where $L_1 > L_2$,

wherein said non-uniform noise energy divides into two components at the inlet of each of the tubes of the at least one array of tubes, a first component of the non-uniform noise energy propagates through each of the tubes over the length L_1 and a second component of the non-uniform noise energy propagates through the enclosure over the effective length L_2 such that when the non-uniform noise energy exits the outlet of each of the tubes, the non-uniform noise energy is out-of-phase and recombines with the non-uniform noise energy propagating over the effective length L_2 thus reducing the noise levels generated from the means for generating noise energy.

2. The noise reduction system of claim 1, wherein the enclosure has an outlet.

3. The noise reduction system of claim 2, wherein the array of tubes is positioned proximate to one of the inlet and outlet of the enclosure.

4. The noise reduction system of claim 1, wherein the enclosure is substantially tube shaped and the at least one array of tubes is positioned in a circumferential array about the enclosure.

5. The noise reduction system of claim 1, wherein:

the means for generating noise is a turbofan engine and the enclosure is an engine compartment housing the engine, the engine compartment includes a fan inlet, a fan outlet and an air passageway between the fan inlet and the fan outlet, and the turbofan engine including a fan located proximate to the fan inlet, and

portions of the fan inlet, the fan outlet and the air passageway between the inlet and the outlet of each of the tubes have the effective length L_2.

6. The noise reduction system of claim 5, wherein:

the fan generates noise energy which propagates toward the fan inlet, and

the at least one array of tubes are circumferentially positioned at the fan inlet in order to reduce the noise levels generated from the fan.

7. The noise reduction system of claim 5, wherein:

the fan generates noise energy which propagates toward the fan outlet, and

the at least one array of tubes are circumferentially positioned at least at one of the fan outlet and the air passage in order to reduce the noise levels generated from the fan.

8. The noise reduction system of claim 5, wherein the engine compartment includes a passive liner treatment and the at least one array of tubes are embedded in the passive liner treatment.

9. The noise reduction system of claim 5, wherein the noise energy propagating through each tube of the at least one array of tubes has a longer propagation path than the noise energy propagating through portions of the fan inlet, the fan outlet and the air passageway between the inlet and the outlet of each of the tubes.

10. The noise reduction system of claim 5, wherein each tube is oriented along a longitudinal direction of the engine.

11. The noise reduction system of claim 5, wherein each tube is oriented at an angle with respect to an engine axis such that a re-entrance point of each of the tubes is at a different angle upstream in the inlet than which it originated.

12. The noise reduction system of claim 5, wherein each tube of the at least one array of tubes is positioned at various axial locations with respect to an engine axis.

13. The noise reduction system of claim 12, wherein the at least one array of tubes is positioned in a helical configuration.

14. The noise reduction system of claim 1, wherein each tube of the at least one array of tubes is oriented along a longitudinal direction of the means for generating noise.

15. The noise reduction system of claim 1, each tube of the at least one array of tubes is oriented at an angle with respect to an axis of the means for generating noise such that a re-entrance point of each of the tubes is at a different angle upstream in the inlet than which it originated.

16. The noise reduction system of claim 1, wherein each tube of the at least one array of tubes is positioned at various axial positions with respect to an axis of the means for generating noise.

17. The noise reduction system of claim 16, wherein the at least one array of tubes is positioned in a helical configuration.

18. The noise reduction system of claim 1, wherein dimensions of each of the tubes of the at least one array of tubes are dynamically adapted to eliminate certain noise energy frequencies generated by the means for generating noise energy.

19. The noise reduction system of claim 1, wherein each of the tubes of the at least one array of tubes are at least one of identical and independent with respect to each other.

20. The noise reduction system of claim 1, wherein reducing the noise levels reduces noise frequencies for both tonal and broadband noise components.

21. The noise reduction system of claim 1, wherein each of the tubes of the at least one array of tubes have a cross section area of A_1 and the enclosure between the inlet and outlet of each tube has a cross section area of A_2.

22. The noise reduction system of claim 21, wherein $A_1 < A_2$.

23. The noise reduction system of claim 21, wherein each of the tubes of the at least one array of tubes have a varying cross section area between the inlet and the outlet.

24. The noise reduction system of claim 21, wherein the cross section area of A_2 is not uniform.

25. The noise reduction system of claim 1, wherein the at least one of array of tubes comprises a second array of tubes which communicate with the apertures in the enclosure and are positioned about the outer surface of the enclosure at a distance from the at least one array of tubes.